



# Appalachian Highlands Science Journal

Welcome to the fourth issue of the *Appalachian Highlands Science Journal*. This magazine is a compilation of articles about natural and cultural research occurring in the parks of the Appalachian Highlands Inventory and Monitoring Network (Big South Fork NRA, Blue Ridge Parkway, Great Smoky Mountains National Park, and Obed Wild and Scenic River). It is produced collaboratively by the staffs of the Appalachian Highlands Science Learning Center, the Appalachian Highlands Inventory and Monitoring Network, the Southeast Exotic Plant Management Team and the Southern Appalachian CESU (Cooperative Ecosystems Study Unit). Several of the articles in this issue focus on the exciting new finds from park inventories and research that are part of the Natural Resource Challenge, a National Park Service initiative to improve park management through greater reliance on scientific knowledge.

Susan Sachs, Education Coordinator,  
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## Network Inventories Net 92 New Fish Species



*Ed Scott, Fisheries Biologist, Tennessee Valley Authority, retired; Nora Murdock, Ecologist, Appalachian Highlands I&M Network*

Mountain redbelly dace from the Blue Ridge Parkway.  
Photo credit: Nora Murdock

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**F**inal results have been compiled and analyzed from four years of extensive fish surveys in Big South Fork National River and Recreation Area, Blue Ridge Parkway and Obed Wild and Scenic River, and include many significant new discoveries. The goals of the inventory were to document the occurrence of at least 90 percent of the fish species likely to occur in each park, and to describe their distribution, habitat usage, and relative abundance within park boundaries.

During the course of the inventories, 92 species of fish were found that were previously unknown from these parks. The Blue Ridge Parkway and Big South Fork NRA now rank among the top 10 most diverse freshwater parks nationwide, with 93 and 92 fish species, respectively.

Samples were collected from 149 sites in the three parks, using a variety of methods and equipment,

including backpack shocking, boat shocking (large river sites and lakes), seines, dip nets, gill nets, trot lines, minnow traps, as well as snorkeling and underwater photography in areas where rare or sensitive species were believed to occur. Sampling was divided between structured surveys and general searches in all habitat types present in selected stream segments. Streams of various sizes were chosen to increase the likelihood that the majority of fish diversity would be observed. Digital photographs were taken as “photographic voucher specimens,” along with a limited number of preserved voucher specimens of cryptic species. A total of 26,463 individual fish were caught and identified during the course of the project. State agency personnel from Virginia, North Carolina, Tennessee and Kentucky participated, *continued on page 2*

# Network Inventories Net 92 New Fish Species

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along with volunteers from numerous organizations and universities, contributing hundreds of hours.

Several rare species and significant finds were documented in Network parks, including the Federally-listed threatened blackside dace (*Phoxinus cumberlandensis*)—a completely new discovery for Big South Fork. Two other Feder-

ally-listed species, already known to the parks, were found as well—the duskytail darter (*Etheostoma percnurum*) (now reclassified as the tuxedo darter, *Etheostoma lemniscatum*, which occurs only in the Big South Fork); and the spotfin chub (*Erimonax monachus*), documented with underwater video at the Obed. Eight additional state-listed rare species were found. One of the new species found at Big South Fork, the Johnny darter (*Etheostoma nigrum nigrum*), had not been reported from the Big South Fork drainage since 1893. The pallid shiner (*Hybopsis amnis*), also found at Big South Fork, was the first collection from Kentucky in 60 years. A pumpkinseed (*Lepomis gibbosus*), a new species caught in the Blue Ridge Parkway (although it may be introduced), was the first of its kind caught in western North Carolina and the first reported from the French Broad River drainage.

At Big South Fork, this inventory documented the encouraging fact that present-day fish diversity, along with water quality, is in the process of recovery from past abuses. In the 1970's, numerous authors noted serious pollution of the river and its tributaries resulting from strip mining and acid mine drainage, forestry practices, industrial, domestic and agricultural runoff, and oil exploration and extraction. The Clean Water Act of 1973 was still in its formative stages at that time, but has since resulted in improved water quality downstream from permitted industrial and municipal wastewater discharges. The Surface Mining Control and Reclamation Act (SMCRA) was passed in 1977 to require reclamation of surface mines and to control runoff of harmful mining by-products, which also helped restore water quality in affected watersheds. Establishment of the park in 1974 further enhanced protection of the river's watersheds. The documentation of 92 fish species during this inventory (79 species captured in NPS-funded work, plus 13 additional species recently documented by others) represents a 64% increase over the 56 species reported in the Big South Fork drainage in 1972, and a 10% increase over the 44 species reported from the same vicinity in 1982, indicating a remarkable and positive trend toward recovery.

Photo-vouchering a fish species.  
Photo credit: Nora Murdock



Duggers Creek on the Blue Ridge Parkway. Photo credit: Ed Scott

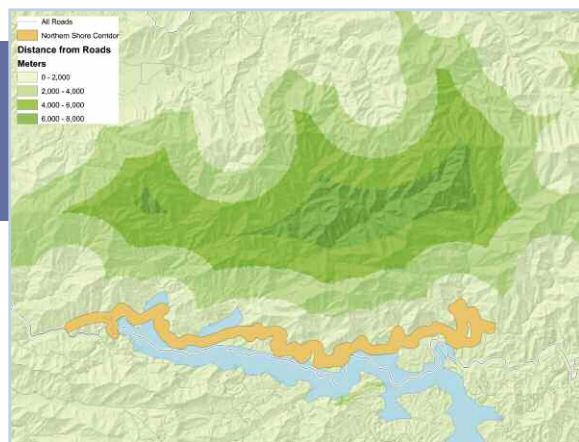
## Landscape Data Guide Available to Parks

*Patrick H. Flaherty, Data Manager, Appalachian Highlands I & M Network*

NPScape is a landscape dynamics monitoring program that provides landscape-level data and evaluations for park natural resource management and planning at local, regional, and national scales. The need for such a program is critical because changes in land cover, land use, habitat connectivity and isolation, natural ecological disturbance regimes, and other landscape-level factors profoundly affect park natural resources. The maps, graphs and tables produced from the data will assist park man-

agers in identifying potential threats and vulnerable landscapes.

A detailed data interpretation guide available to every park will provide best practices for creating maps, graphs, and tables to communicate findings. The reference records are presently available via the NRInfo Data Portal (<http://nrinfo.nps.gov/Home.mvc>) and Natural Resources Information Portal. Geospatial data may be obtained by contacting park GIS Specialists and Data Managers.



Map used for depicting impacts of a proposed road.

More information may be found through the NPS internet at: <http://science.nature.nps.gov/im/monitor/npscape/index.cfm>

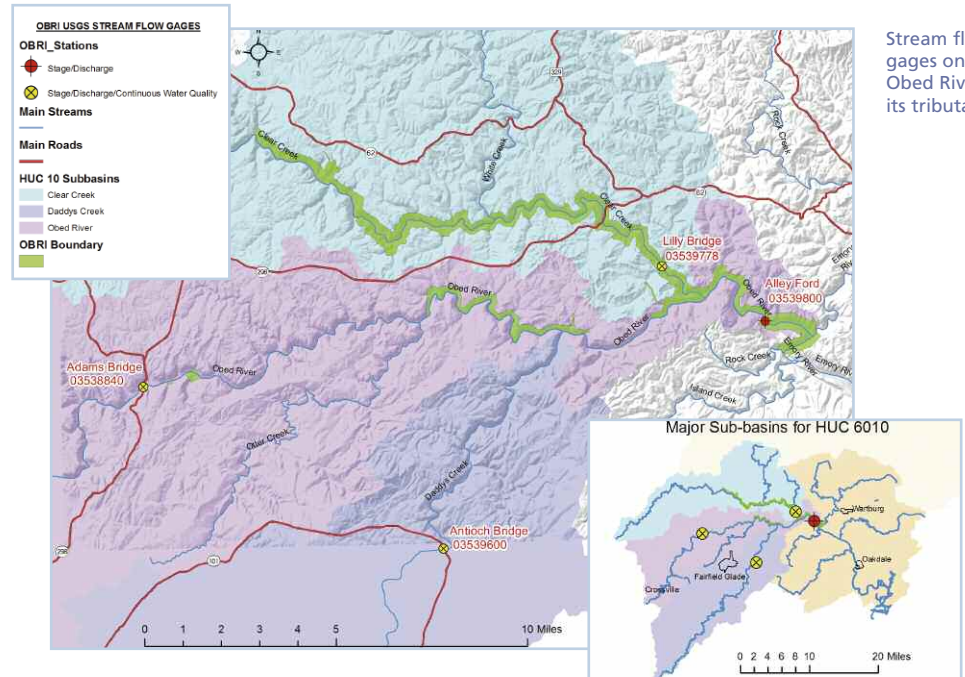
# NPS Partnership Brings Real Time Water Quality Monitoring to the Obed Wild and Scenic River

James Hughes, Hydrologist, Appalachian Highlands Inventory and Monitoring Network (APHN)

The National Park Service (NPS), the U.S. Geological Survey (USGS), and the Tennessee Wildlife Resources Agency (TWRA) share a number of common interests related to science in support of management and conservation of natural resources. One of these common interests is the need for quantitative information about water resources. Reliable and timely data on streamflow, water levels, flood magnitude and frequency, and drought characteristics are needed for park scientists and managers to adequately understand and manage water rights, visitor safety, water supplies, facilities, transportation, recreation, aquatic and riparian ecosystems, and water quality.

Water resource integrity is especially important to the Obed Wild and Scenic River (Obed WSR), which was designated as such in 1976 by amendment of the Wild and Scenic Rivers Act of 1968 (PL 90-542). Water resources and riparian habitat are the principal resources of the OBRI, which includes only those lands within narrow stream corridors of the Obed proper and Emory Rivers as well as of Daddys Creek and Clear Creek, major tributaries to the Obed. Waters of the Obed system are considered to be among the highest quality in Tennessee, and these waters and adjacent riparian areas support a rich and unique ecological diversity.

Land use activities adjacent to the OBRI influence and may threaten the integrity of park waters and riparian resources. Upstream urban and suburban growth and associated increase in water demand, wastewater discharge, and a proliferation of recreational and water supply impoundments are important management concerns. Additionally, the effect of coal mining and stone quarrying, oil and gas extraction, logging, and agricultural runoff must be evaluated to manage water resources of the Obed system, both within and outside of designated park waters. Under the Wild and Scenic Rivers Act, NPS is directed to ensure that the waters of the Obed should be preserved “in their free flowing condition to protect the water quality and to fulfill other vital national conservation purposes.” Management of Obed waters towards that end is heavily reliant upon streamflow data, both to evaluate adequacy of streamflow to sustain aquatic life and to complement water quality data to determine pollutant loads and assimilative capacities.



Stream flow gages on the Obed River and its tributaries.

Long-term, accurate, and unbiased information on streamflow, which is made available through the USGS National Streamflow Information Program (NSIP), is a key component of effective management of NPS water resources on a national level. Unfortunately, the funding and effort devoted to operation of stream gages in National Parks decreased by ten percent from 1970-2006, while total acreage and number of parks (many of which prominently feature riverine resources) in the NPS system nearly doubled. Trends at the national level have also been reflected in recent years at Obed WSR as well as at the Big South Fork National River and Recreation Area (BISO), where funding constraints have threatened the integrity of critical stream gage networks in both parks. In response to these threats, APHN has partnered with USGS to share operation and maintenance duties for streamflow gages at both OBRI and at BISO, providing a reduction in yearly costs for both parks while maintaining the integrity of the gage networks.

In a departure from recent trends at the national level, the water resource monitoring infrastructure at OBRI has been significantly upgraded during the past year through a combination of funding initiatives and internal (OBRI/APHN) and interagency partnering with USGS and the Tennessee Wildlife Resources Agency (TWRA). Recent enhancements to the OBRI water resource infrastructure include construction of a new streamflow gage on the Obed River at Adams Bridge, purchase and deployment of continuous water quality monitoring instrumentation, and approval of Small Park Grants for stream gage development. In concert with these efforts, the existing partnership between APHN and USGS has been refined to allow cost free use of USGS telemetry and web domain to broadcast real time water quality data to the internet.

The shared efforts of federal and state partners are exemplified by the evolution of the Obed gaging network during recent years. When the need for an additional gage was identified through initial water quality monitoring efforts conducted under the Inventory and Monitoring program in 2009, APHN and OBRI staff collaborated to successfully solicit necessary funding for the Adams Bridge gage and for improvements to deteriorating infrastructure at the existing Obed River near Lancing gage. The Adams Bridge gage was initially funded solely as a stage/discharge gage, with funding to be made available in 2011. Fortunately, a 2009 increase in base funding at OBRI allowed for accelerated construction of the gage during FY 2010 and also provided funds to allow the Adams Bridge gage to be equipped with water quality instrumentation.

Cost estimates for USGS operation of a single water quality (QW) gage *continued on page 4*

# NPS Partnerships Brings Real Time Water Quality Monitoring to the Obed Wild and Scenic River

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at Adams Bridge were deemed cost prohibitive. Instead, APHN provided technical guidance and OBRI invested the initial capital (available through the base fund increase) to purchase three YSI 6920 water quality sondes and appurtenances. These sondes will be deployed not only at the Adams Bridge gage on the Obed, but also at USGS gages on Clear Creek and Daddys Creek, providing real time water quality coverage at each of the three primary stream components designated for protection as Wild and Scenic under the OBRI enabling legislation. The water quality stations will be operated and maintained by APHN at a cost savings of

approximately \$25,000 per annum each (\$75,000 yearly total) in comparison to contracting with USGS for the same data. Although operation of the sondes by USGS was deemed cost prohibitive, USGS nevertheless provided cost free telemetry and use of their web domain to allow broadcast of the water quality data to the internet.

With the recent addition of the Obed River at Adams Bridge gage, streamflow data will be available for the Obed system at a total of four gages, three of which will also provide real time water quality (QW) monitoring (see map insert). These improvements to the OBRI water resource monitoring infrastructure have not been realized through a single funding source or by the efforts of a single entity. Instead, strengthening of the Obed network has evolved through shared funding and manpower, both internally within NPS and externally with state and federal partners. These combined efforts have allowed for substantial improvements to the water resource monitoring and management capabilities at the OBRI during a period of fiscal constraint. The data provided by these efforts will be a valuable supplement to ongoing monitoring by the I&M program, and will be an asset not only to the National Park Service, but to other federal, state, municipal, and private partners.

## Orphaned Oil and Gas Wells to be Plugged at Big South Fork National River and Recreation Area

*Todd Knoedler, Geologist, NPS, Big South Fork National River and Recreation Area*  
*Jason McVay, SCA intern, NPS, Appalachian Highlands I&M Network*

In June 2010, work began to plug and reclaim 53 oil and gas wells in Big South Fork National River and Recreation Area, in TN and KY. This high-profile project is the largest undertaking of its kind in the history of the NPS, and represents one of the most important mitigations of threat to visitor safety and resource protection currently ongoing in the eastern U.S.

The 53 wells are orphaned, meaning no responsible party has been identified and the wells were simply abandoned. When the 125,000 acre park was formed in 1974, the National Park Service assumed responsibility for the oversight of these orphaned wells.

Above ground, most of the well sites are little more than a rusty pipe sticking out of the ground and the occasional abandoned storage tank or pump jack and refuse. But below ground, these orphaned wells present a number of problems. First, they are a hazard to visitor safety. Many of the wells leak natural gas at the surface, which is combustible and displaces breathable air. The potential for groundwater contamination is another serious issue. Big South Fork is considered a Tier III Outstanding National Resource Water site under the Clean

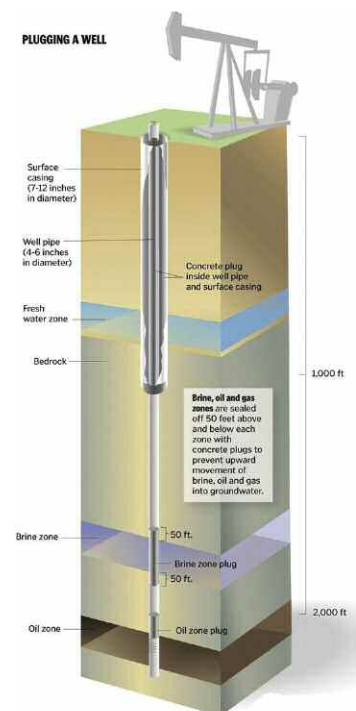
Water Act, which mandates protection of water quality. Although there are no current indications of subsurface mixing, plugging is important to protect water resources.

The Big South Fork region has an extensive extraction history. Coal mining began here in the late 1800s, and Big South Fork is also home to the first commercial oil well drilled in the United States. In 1818, the Martin Beatty well was drilled in search of brine for salt extraction. Instead, drillers hit a pressurized oil bearing zone. At that time, crude oil had no value as an energy source. Instead, the oil was shipped to Europe for its assumed medicinal value. Most of the current wells in Big South Fork were drilled in the 1970s and '80s.

Today there are over 300 wells inside the park, most of which have been safely capped and plugged or are still owned by individuals who lease the mineral rights. The remaining active oil wells are slow but consistent producers of oil, churning out up to five or six barrels a day. There are also several producing gas wells.

Funds made available from the American Recovery and Reinvestment Act will enable the NPS to plug 39 of the orphaned wells. The remaining 14 wells are being plugged through alternate funding in a joint venture with the State of Tennessee.

The Beatty well is one of the 53 wells slated to be plugged. Surface features of this well will be restored to preserve its historical significance as the first American oil well.



Generalized drawing of oil well plugging operation (not to scale); actual field conditions will vary at each site  
Art credit: Don Wood, Knoxville News Sentinel

# Calcium Limitation in Southern Appalachian Songbirds

Becky Keller, Ph.D. Candidate, North Carolina State University

Acid precipitation remains a critical environmental stress to eastern forests, and the southern Appalachians have some of the highest annual precipitation rates in the continental United States, often exceeding 200 cm. Acidic clouds bathe the high elevation forests in the southern Appalachians during much of the growing season, with an average acidity of 3.5 pH in the high elevation forests of Great Smoky Mountains National Park (GRSM). At times, acidity has been measured as low as 2.0 pH (e.g., stomach acid!). Atmospheric deposition monitoring data inside GRSM indicate that annual wet nitrogen deposition (one of the primary elements of acid precipitation) increased 22% between 1981 and 1999, while calcium deposition decreased by 24% over the same period.

High elevation red spruce (*Picea rubens*) – Fraser fir (*Abies fraseri*) habitat is located only in the southern Appalachians, with approximately 75% located within GRSM. The red spruce-Fraser fir forest ecosystem, found only above 3,500 feet, is in jeopardy due to the synergistic effects of heavy fir loss by the invasive balsam woolly adelgid beetles (*Adelges piceae*), foliar damage by high levels of ozone, and the direct and indirect effects of acid precipitation. High elevation soils are receiving such large quantities of nitrogen through acid precipitation that the ecosystem is suffering from advanced nitrogen saturation.

Calcium is one of the cations that is stripped from the environment by acid precipitation. Reductions in environmental calcium have been tied to reductions in populations of aquatic invertebrates and terrestrial snails, and more recently associated with reproductive problems in birds. These effects may be particularly important at high elevations, where native calcium is limited.

Readily available environmental calcium is extremely important for female birds during the breeding season. Medullary bone, found only in female birds during reproductive seasons, offers a base of calcium storage that some birds draw from during egg laying. However, small birds have far too little calcium available as medullary bone to produce a clutch of eggs. Having very little physiological storage capacity, many female songbirds collect nearly all of the calcium they need in the weeks just prior to egg laying.



Author Becky Keller holds a Dark-eyed junco.  
Photo credit: Becky Keller

Although millipedes and isopods are prey items rich in calcium, snail shells are the primary source of calcium for most forest birds.

Research in the Netherlands has dramatically linked the effects of acid deposition to reductions in snail populations, thinner avian egg shells, and lower reproductive success in songbirds. In North America, studies on Tree Swallows (*Tachycineta bicolor*) showed that female birds in areas with decreased calcium expended more energy than normal, traveling further to locate calcium-rich prey and losing more weight during the breeding season. In the northern Appalachians, there is some evidence that declines in Wood Thrush (*Hylocichla mustelina*) populations are related to high levels of acid precipitation.

For this study, my doctoral advisor, Dr. Ted Simons of North Carolina State University, and I used the Dark-eyed Junco (*Junco hyemalis carolinensis*) as a model for evaluating the effects of acid precipitation on high elevation bird communities in the Southern Appalachians.

The “Carolina Junco” is a subspecies of the Dark-eyed Junco that commonly breeds in the higher elevations of GRSM. Juncos are abundant in the high elevation spruce-fir forests and often produce more than one clutch in a season. We expected juncos to show signs of calcium deficiency before other bird species which nest only once per season.

We hypothesized that calcium limitation was affecting the behavior and breeding success of Dark-eyed Juncos, and tested the following predictions: 1) the calcium content of junco eggs would be negatively correlated with acid deposition (i.e., eggs in more acidic areas would have less calcium); and 2) birds that have access to additional calcium would have larger eggs, more eggs, and higher nesting success than birds in areas without added calcium.

To test our first prediction, we collected eggs from Dark-eyed Junco nests in high elevation areas in GRSM in spring and summer of 2006. We then measured and analyzed the eggs for calcium content at North Carolina *continued on page 6*

# Calcium Limitation in Southern Appalachian Songbirds

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State University. We found evidence to support our prediction, as eggs in areas of higher deposition had significantly less calcium.

We tested our second prediction in the summers of 2007 and 2008 by setting up experimental plots throughout the spruce-fir habitat around and between the Clingmans Dome and Newfound Gap areas. In our treatment plots, we set out additional calcium for the birds in the form of crushed oyster shell, plus a little bird seed to initially attract the birds to the calcium. In our control plots, we put out only bird seed. Any time we lingered to watch, juncos would locate the bird seed and start eating it within 15 min after we set it out. We microwaved all bird seed prior to setting it out to avoid introducing non-native vegetation to GRSM. Plots were separated by at least 400 m to make sure they were independent, and we visited the plots throughout the breeding season to search for junco nests. We found a total of 86 junco nests in the control and treatment plots over 2 years that we used in our analyses. We visited each nest every 3-5 days to monitor nesting success.

Our findings are all preliminary at this stage, however our analyses indicate that the

additional calcium we set out did not result in larger eggs, more eggs, nor increase nesting success for juncos in the treatment plots. If the effects of reduced calcium are subtle, our negative results may be a function of our low sample size. The overall nesting success for juncos in this study varied between 10.5% in 2007 and 25.5% in 2008.

Although these values seem low, they are similar to those found in other studies of Carolina Juncos. Like many ground-nesting birds, juncos are known to have low nesting success, which appears to be largely a function of small-mammal population fluctuations. Our observed nest predation rates of 69% (2007) and 40% (2008) fall within the range (20-85%) observed at Mountain Lake Biological Station in Virginia.



Research Assistant Carmen Vanbianchi carefully extracts a junco from a mist net.  
Photo credit: Becky Keller

Thus, the story of acid precipitation and its effects on songbirds in the Southern Appalachians is mixed, which has often been the case in other studies across North America and Europe. We anticipated that the effects of acid precipitation may be subtle for songbirds, so we chose to pair our research on birds with a related study on terrestrial snails in GRSM. Snail shells are composed almost entirely of calci-

um carbonate and may show evidence of calcium limitation sooner than birds. We are eager to analyze our results looking at species richness and diversity of snail populations in relation to acid deposition in GRSM. Between these studies we hope to better describe the effects of acid precipitation on animals in the park.

These studies were supported by United States Geological Survey, The U. S. Forest Service, and the Appalachian Highlands Science Learning Center. Two international interns participated in this project through the Partners in Flight program (see sidebar). Numerous high school interns also gained important early scientific experience on this field project, which was supported through the Burroughs Wellcome Fund.

## INTERNS FROM NEAR AND FAR LEND A HAND

Becky Keller's work would not have been possible without the assistance of several interns, both local and international. Ms. Keller helped the park to host two international interns—Pablo Elizondo of Costa Rica and Ruth Partida Lara of Mexico—under the National Park Service's Park Flight Program, an effort to improve the conservation of Neotropical migrant birds in protected areas through developing bird conservation and education projects and creating opportunities for technical exchange and cooperation. Mr. Elizondo has been active with Costa Rican National Parks and Ms. Lara is now studying hummingbirds for her graduate work. In addition, Ms. Keller also worked with two high school interns each year, a program supported by grants through the Friends of the Smokies from the Burroughs Wellcome Fund and Toyota, USA. While helping Ms. Keller's research, each intern learned a great deal about field research techniques and birds. "I will never forget the majesty of these mountains and the amazing people who I worked with or met in the Smokies and all I learned from them," wrote Ruth Partida Lara.



Pablo Elizondo shares in the excitement as a young park visitor helps release a junco.  
Photo credit: Anna Catherine Super

# National Parks as Potential Reserves for the Conservation of Aquatic Insects

Dr. Charles R. Parker, Research Aquatic Biologist, USGS

The southeastern United States possesses a remarkable number of aquatic species, and is well known as a center of diversity for freshwater fish and mussels. Less well known is the fact that the Southeast also has an equally important diversity of aquatic insects, with an estimated 270 species of mayflies (*Ephemeroptera*), 150 species of stoneflies (*Plecoptera*), and 600 species of caddisflies (*Trichoptera*)—more than a third of all species in those groups known from North America. Unfortunately, it is widely acknowledged that fish and mussels in the Southeast are at great risk, with some species feared extinct and others in decline. The status of aquatic insects in the Southeast is not as well known as the status of fish and mussels. However, a recent evaluation suggested that dozens of species of mayflies, stoneflies, and caddisflies are vulnerable to extirpation in just the Southern Appalachian Mountains. Fortunately, a number of these at risk species have healthy populations in the Great Smoky Mountains National Park. Recent studies have revealed 120 species of mayflies, 111 species of stoneflies, and 231 species of caddisflies in that park. The protected status of the park means that those species are less likely to be at risk than other species which do not have populations in protected areas such as national parks, national forests, or other reserves. In 2005 a study was undertaken to assess the potential of national parks in the Appalachian Highlands and Cumberland Piedmont I & M Networks as reserves for the conservation of aquatic insects.

A total of 17 parks were surveyed over three years. Using light traps, sweep nets, dip nets, and hand collecting, and concentrating on the adult stage (adults are more reliably identified than the immature stages of most species), a total of 631 species were found: 138 *Ephemeroptera*, 133 *Plecoptera*, and 360 *Trichoptera*. This represents more than 60% of the known Southeastern species of those groups. Since at least some pop-



Little River in the canyon at Little River National Preserve, Alabama.  
Photo credit: Chuck Parker



Dry Creek at its entrance to Russell Cave National Monument, Alabama. Photo credit: Chuck Parker

ulations of each of these species are found within the boundaries of at least one national park, these species should receive the benefit of the protected status that those areas provide. Sixteen of the 17 national parks in this study harbored at least one species not found in any of the other 16 parks, a remarkable measure of the significance that even small historical parks can play in the conservation of aquatic insects. At the same time, however, more than 500 species occurred in just three or fewer parks. While many of these occurred in the large natural area parks (e.g., Great Smoky Mountains and Blue Ridge Parkway), others occurred in small historical and battlefield parks. In conservation, size matters, as small, isolated populations are more likely to struggle and have difficulty recovering successfully if they are stressed by environmental changes than are large populations with other nearby populations that can serve as sources for recovery. This means that these parks should implement water quality monitoring to

ensure that the environments of these species remain healthy.

One further consideration is evident when one examines the data from Great Smoky Mountains National Park. Entomologists have collected in the Smokies for decades, and the park has data from thousands of collections from across its landscape. This represents a level of effort much greater than in any of the other parks in the study. The relationship between the number of collections made/specimens examined and the number of species found is extremely strong, with an  $r^2$  of 0.98. This implies that the numbers of species found in each park will continue to rise with additional inventories and that efforts to truly understand the biota of each park and monitoring network, and the role the parks play in aquatic insect conservation, will require much more work.

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# National Parks as Potential Reserves for the Conservation of Aquatic Insects

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## PARKS OF THE APPALACHIAN HIGHLANDS AND CUMBERLAND PIEDMONT INVENTORY AND MONITORING NETWORKS, WITH PARK AREA AND THE NUMBER OF UNIQUE SPECIES FOUND IN EACH PARK

PARK	HECTARES	NUMBER OF UNIQUE SPECIES
Big South Fork NRRRA	49,545	4
Blue Ridge Parkway	33,093	37
Great Smoky Mountains NP	209,998	150
Obed WSR	3,769	14
Abraham Lincoln Birthplace NHP	138	1
Chickamauga & Chattanooga NMP	2,279	8
Cowpens National Battlefield	340	3
Cumberland Gap NHP	8,118	13
Fort Donaldson NB	210	1
Guilford Courthouse NMP	82	1
Kings Mountain NMP	1,583	1
Little River Canyon NP	5,586	18
Mammoth Cave NP	20,791	5
Ninety Six NHS	384	9
Russell Cave NM	130	0
Shiloh NMP	1,605	10
Stones River NB	261	2
<i>Total number of species found in only one park</i>		277

## OBRI AQUATIC MACROINVERTEBRATE SURVEY INDICATES (MOSTLY) GOOD WATER QUALITY

A recently completed aquatic insect survey of Obed Wild and Scenic River by Dr. Brad Cook and Benjamin Hutton of Tennessee Tech, represents the first time a comprehensive survey of this kind, focused exclusively on the park's rivers and streams, has been done. The data from this study provides a measure of current aquatic ecosystem health, and serves as a baseline against which future aquatic insect surveys can be compared.

For the study, thirty-six sampling sites were distributed among the park's sub-watersheds, from the smallest perennial stream to the largest river within the park. The study resulted in a total of 176 aquatic insect taxa being identified. Water quality index values based on collection results indicate that, with the exception of the Emory River, aquatic macroinvertebrate community health within the Obed Wild and Scenic River system is very good.

This kind of information is important for the Obed because the main natural resource issues facing the park are related to its efforts to preserve the "outstandingly remarkable" character of park waters—the reason it was designated a Wild and Scenic River. Resource management challenges involve not only protecting park waters, but defining baseline conditions, so that the park can more effectively manage potential resource threats.



A stonefly nymph (*Acroneuria* sp.) commonly found at Obed WSR. It is an indicator of generally good water quality conditions.  
Photo credit: Rebecca Shifflet

# White-Nose Syndrome Hits Home

Jason McVay, SCA Intern, NPS, Appalachian Highlands I&M Network

In early 2010, Tennessee became the tenth state to report cases of white-nose syndrome (WNS) in bats. In April, WNS was confirmed in one little brown bat inside Great Smoky Mountains National Park. First observed in a New York cave in 2006, WNS has spread swiftly across the east coast, decimating bat populations at an extraordinary rate. Named for the white fungus that appears on the face of infected bats, WNS causes bats to act erratically and rapidly deplete their fat reserves during hibernation. The bats awake in midwinter, disoriented and hungry, and proceed to hunt during the day for non-existent insects. In four years over one million bat deaths have been attributed to WNS.



Little brown bat; close-up of nose with fungus, New York, Oct. 2008.  
Photo credit: Ryan von Linden/New York Department of Environmental Conservation

Mortality rates in some colonies have neared 100%. From Vermont to Virginia, thousands of bats once found hibernating in healthy populations are now found dead at many cave entrances. Currently, six known species of bats have been identified as infected with WNS. White nose syndrome has the potential to cause widespread population decline and even extinction of these bats and others on the east coast and across North America.

Although bat-to-bat contact is believed to be the major route for the spread of WNS, some evidence suggests that humans may inadvertently transport the disease to clean sites. Because of this, the U.S. Fish & Wildlife Service has advised all people visiting caves and other suitable bat habitats to sterilize their clothing and shoes afterwards. As of 2008, a moratorium has been placed on all caving activities in infected areas. Little is known about WNS, and researchers are actively studying it in hopes of finding a root cause and potential solution to this escalating problem.

The North Carolina Wildlife Resources Commission will be monitoring bat populations throughout western North Carolina this summer in an effort to assess bat health. Staff in Great Smoky Mountains National Park will be assisting in these efforts as well as continuing to monitor bat populations in the Tennessee section of the park.

To view a new video on bats and white nose in the Smokies, visit <http://www.nps.gov/grsm/photosmultimedia/wns-bat-video.htm>

## Plant Poaching on the Blue Ridge Parkway

Nora Murdock, Ecologist, Appalachian Highlands I&M Network

Commercial-scale illegal harvesting of plants for sale in medicinal and floral markets is of growing concern in many parks. Numerous species targeted by poachers are found in the Blue Ridge Mountains and there is evidence that poaching is increasing. Some of these species do not recover quickly (or at all) from intensive harvesting, and are being eliminated from habitats that are accessible to poachers. This is of particular concern on the Blue Ridge Parkway (BLRI), where individual poachers have been intercepted leaving the park with tens of thousands of plants.

The Appalachian Highlands Inventory & Monitoring Network (APHN) is monitoring

several plant species known to be significant poaching targets, including black cohosh (*Actaea racemosa*), bloodroot (*Sanguinaria canadensis*), several trillium species (*Trillium* spp.), and ginseng (*Panax quinquefolius*). Using GIS-based predictive habitat models developed by the U.S. Forest Service and NatureServe, and incorporating data from newly-completed vegetation maps for the Blue Ridge Parkway, Network staff are locating and establishing a series of permanent plots throughout the park for long-term monitoring of the target species.



Bloodroot (*Sanguinaria canadensis*).  
Photo credit: Nora Murdock

Early results of monitoring: over the past two years, 200 sites predicted to be suitable habitat for ginseng have been visited and evaluated, with only 42 ginseng populations being found. Virtually all of these have shown signs of heavy poaching, with population age structure skewed toward younger, non-reproducing plants. Only one of the 42 populations contained more than 30 plants (the minimum number believed by some authorities to be necessary for long-term survival), and the vast majority had less than a dozen plants remaining.

# Geologic and Geohazards Inventory on the Blue Ridge Parkway

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In 2000, the North Carolina Geological Survey (NCGS) began a project to produce a geologic and geohazards inventory of the North Carolina section of the Blue Ridge Parkway (BLRI) and the Carl Sandburg Home National Historic Site (CARL). The National Park Service contracted with the NCGS to produce this geographic information system (GIS)-based geologic resources inventory as part of a pilot study for developing similar digital geologic resource inventories at other National Parks. Geologic field mapping was done at 1:12,000 scale with digital orthophotography as a base layer using an integrated GPS/GIS device

(Trimble GeoXM™ with ArcPad™). The North Carolina project was completed in October 2008 with the delivery of the GIS data layers, database, metadata and supporting digital files.

Geologic and geochemical data are important for many reasons. Geology has a profound effect on the distribution of vegetation types, as well as that of some individual plant and animal species. Geologic data have been a major component of predictive habitat models developed by the U.S. Forest Service for the southern Appalachians. The National Park Service (Appalachian Highlands I&M Network) is using adaptations of these same models to locate long-term vegetation monitoring plots and to select sampling sites for water quality and aquatic macroinvertebrates. Underlying geology is one of the most important factors for predicting buffering capacity of watersheds that are adversely affected by acidic runoff. Rare species, particularly plants and some invertebrates, often occur on particular rock types,

and detailed geologic maps can be used to refine search patterns to find previously unknown populations. In addition, geologic data are useful in developing natural history and interpretive programs for visitors to the Parkway.

Geologic hazards data provide information on two main geologic hazards encountered along the Parkway: landslides and acid-producing rock. The landslide information includes the locations where the Parkway intersects slope movements (i.e., landslides) and slope movement deposits. These point data (Figure 1) include detailed information on type of slope movement or slope movement

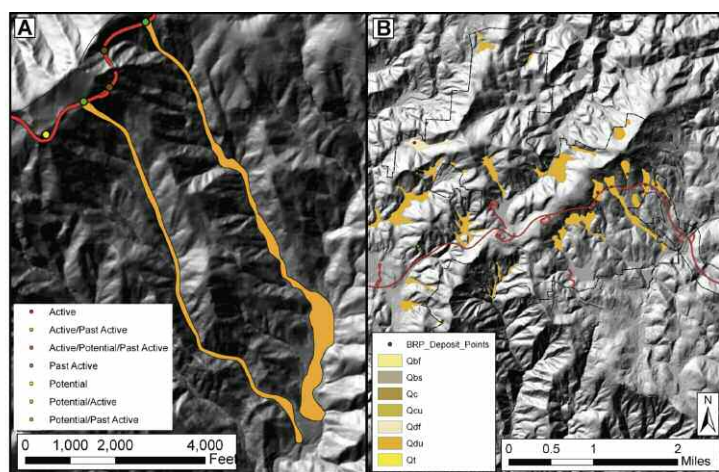


FIGURE 1: Point data layers for slope movements (A) near mile marker 349 and slope movement deposits (B) in the Julian Price-Moses Cone area. Points indicate where the Parkway encounters the feature, while the tracks polygon (A, shown in orange) and deposits polygons (B, see explanation for types of deposits) show the mapped extent of these features. The debris flows mapped in A occurred during Hurricane Frances, September 6-8, 2004.

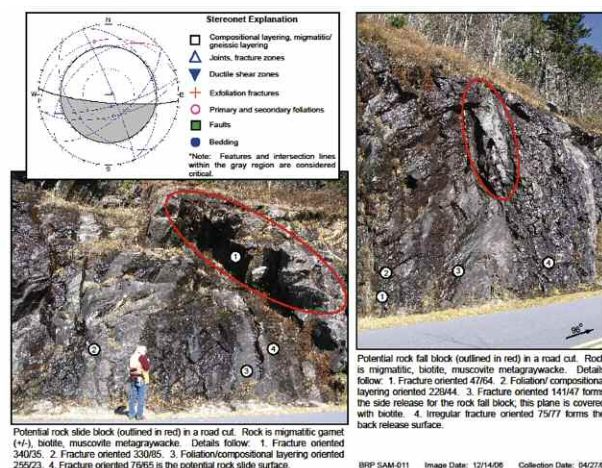


FIGURE 2: Example of a geologic rock slope data sheet. This data sheet is for an outcrop with potential rock fall and rock slide at mile marker 425. It shows kinematic stereonet analysis (top left) along with annotated photographs of the potential rock slide and rock fall at this location. Rocks here are metasedimentary rocks (migmatitic metagraywacke) of the Ashe Metamorphic Suite/Tallulah Falls formation.

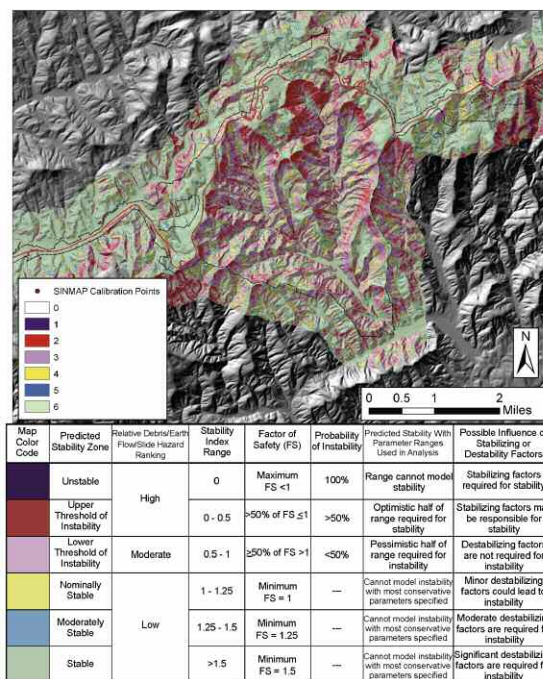


FIGURE 4: (above) Sulfide and iron oxide minerals visible in a metasandstone outcrop at MM 426.5. Pyrite crystals (blue arrows) are visible in the outcrop, and the yellow and dark orange surface staining also indicates the presence of sulfide minerals.

FIGURE 3: (left) Example of the debris flow susceptibility map in the Doughton Park area on the Blue Ridge Escarpment. This map was created using the GIS based program Stability Index Mapping (SINMAP). Debris flows and flooding severely impacted this area and the Basin Creek Community in a July 15-16, 1916 storm.

deposit, location, movement history, landform descriptions, rock and soil data, structural measurements, and surface and groundwater information. 154 of the 253 GIS process points are linked to geologic data sheets (Figure 2), which contain pictures annotated with the critical discontinuities that have or would likely contribute to slope failure. They also contain bedrock structural data analyses, useful to geologists and engineers in assessing rock slope instability and in designing stable slopes. The landslide point data is displayed according to the level of activity observed during data collection. Level of activity is labeled as past active, active, potentially active, or some combination of those levels. Locations were considered potentially active if large cracks and fissures were observed, and, if failure were to occur, the material would obstruct the motor road.

Landslide deposits are typically composite accumulations of material deposited over geologic time by multiple slope movements that form debris fans. The numerous block stream and block field boulder deposits along the Parkway may reflect past periglacial conditions and mass wasting events. Regardless of origin, the deposits generally represent thick accumulations of unconsolidated material susceptible to slope failure if oversteepened or undercut.

Because landslides and deposits do not just occur in discrete point locations, polygons were drawn where applicable to show the extents of the features (Figure 1). For example, one type of landslide known as a debris flow can travel hundreds or thousands of feet before stopping. The extents of debris flows are important because even though it may start above, or on NPS property, it can quickly travel outside the boundaries and affect adjacent property. A geohazards map layer was also con-

structed to show debris flow susceptibility (stability index) in a corridor extending 500m on either side of the Parkway. This color-coded map shows the relative potential for debris flow initiation on unmodified slopes during major storm events with 125mm or more of rain in a 24-hour period (Figure 3). Major debris flow activity and flooding occurred in what is now Doughton Park during the July 15-16, 1916 storm that devastated the community along Basin Creek (near the NC/VA border on the Parkway).

The second major aspect of the geohazards inventory is the location of acid-producing rock. Naturally occurring, iron sulfide minerals such as pyrite, pyrrhotite, and, to a lesser extent, chalcopyrite (Figure 4) commonly found in some rock groups along the Blue Ridge Parkway can weather through oxidation and hydrolysis (the chemical process in which a certain molecule is split into two parts with the addition of a water molecule) when freshly exposed to create a mild sulfuric acid. This acid runoff can degrade the surface water quality and adversely affect aquatic life. Acid-producing rock can also adversely affect slope stability in rock cuts or when used in road embankments without proper handling or treatment. Point locations where sulfides were visible in hand samples on the Parkway were identified and noted.

Net neutralization potential (NNP) tests were performed by the N.C. Department of Transportation on sixteen rock samples collected from representative rock slope exposures along the Parkway (Figure 5). This test ranks the acid-producing potential of the rock and determines the tons of calcium carbonate (limestone) needed to neutralize 1,000 tons of the material. The geologic units mapped along the Parkway were also classified into high, medium and low potential for the occurrence of acid-producing rock types (Figure 6). This information on acid-producing potential identifies areas where extra care needs to be taken in future design or upgrades.

Rock slopes were given a relative hazard ranking based on the structural data analyses, dimensions of the rock slope, the relative numbers of dilated or open discontinuities, and the presence of potentially acid producing rock. The geohazards data provide a way for the NPS to help prioritize resources and efforts in dealing with slope instability along the Parkway.

Several data layers comprise the geologic inventory. The first map layer depicts regional geologic units at a

*continued on page 12*

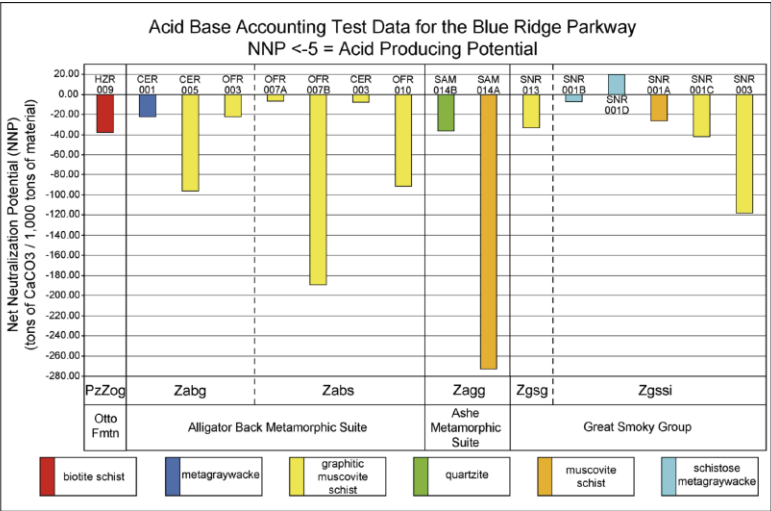


FIGURE 5: Plot of the Net Neutralization Potential test results for the sixteen samples taken along the BRP. Data is grouped by mapped bedrock units and color indicates the rock type. At some data point locations, multiple samples were taken. Figure from Latham et al., 2009.

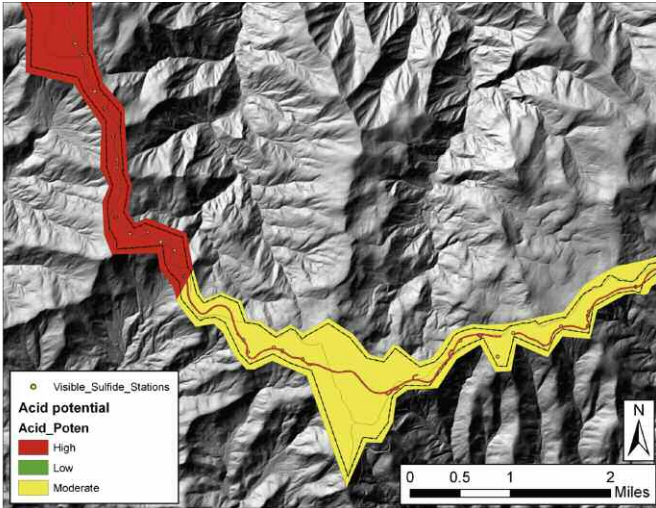


FIGURE 6: Example of acid potential data layer depicting high, moderate, and low potential for acid-producing rock types between MM 420 and 430 near the south end of the Parkway. Point data show locations where sulfide minerals were observed in outcrop. Classifications of the acid-producing potential were based on the mapped bedrock geologic units.

# Geologic and Geohazards Inventory on the Blue Ridge Parkway

*continued from page 11*

1:250,000 scale (Figure 7). These broad, formation and group categories can be correlated to other regional geologic maps. The next map layer depicts the bedrock units mapped at 1:24,000 scale and larger, and these units are subsets of the regional map units (Figure 8). A more detailed version of this data set is the outcrop map layer which displays the major rock types encountered at outcrops along the Parkway (Figure 9).

Bedrock structural measurements were also collected during field mapping (Figure 10). These measurements describe the orientation of the fabrics and discontinuities in the rock units such as layering, mineral alignments, folds, fractures, and faults that help to develop the structural and age relationships between rock units. These data are important in assessing rock slope stability and to conceptualize groundwater flow. Representative geologic cross sections constructed at three locations along the Parkway (Doughton Park, Moses Cone, and Craggy Gardens) depict the subsurface geology (Figure 11). These are locations where the park boundary expands beyond the immediate motor road.

Major and minor element geochemical analyses were conducted at 44 locations along the N.C. segment of the Parkway. This testing provides information on the percentages and concentrations of minerals and elements present in the rock. This information is used to more accurately and specifically classify the rock types, and to help identify chemical differences in rock types that may influence vegetation types.

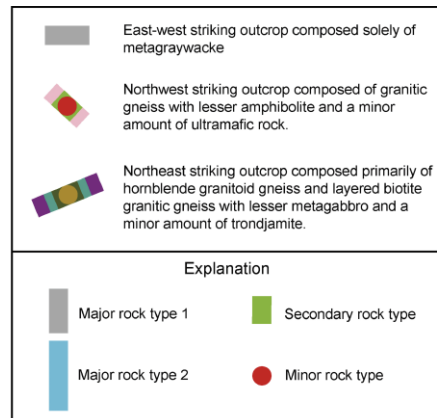


FIGURE 9: Examples and explanation for the symbols used in the rock type data (outcrop) layer. The color of the bar indicates rock type. Symbols are rotated parallel to the trend of the dominant layering.

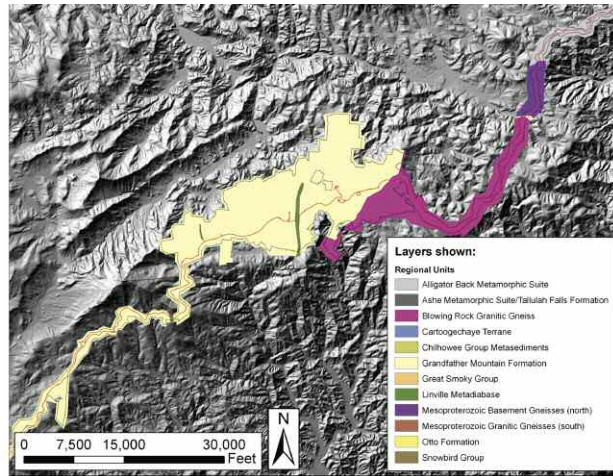


FIGURE 7: Map of the Moses Cone and Julian Price area showing the regional geologic map units layer. This layer is only visible when zoomed out farther than 1:500,000 scale. Base layer is LiDAR hill shade.

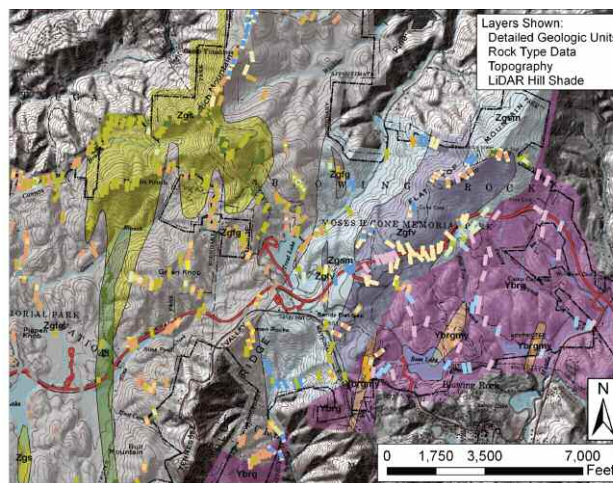


FIGURE 8: Map of the Moses Cone and Julian Price area showing the detailed geologic units layer and the rock type data (outcrop) layers. Geologic mapping and topographic contours are draped over the LiDAR hill shade.

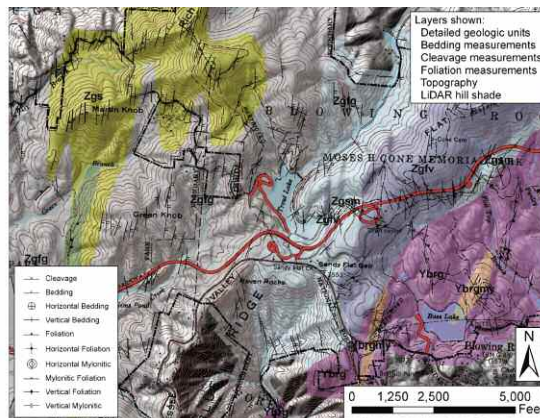


FIGURE 10: Map of the Moses Cone and Julian Price area showing detailed geologic units and examples of bedrock structural data layer (cleavage, bedding, and foliation). Geologic mapping and topographic contours are draped over the LiDAR hill shade.

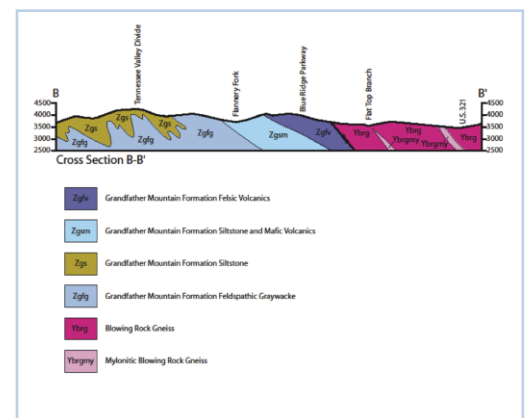


FIGURE 11: Geologic cross section through the Moses Cone area.

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